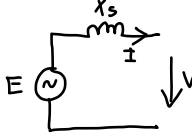


Part 1.

1. B 5. A 9. C
2. B 6. B 10. C
3. B 7. C
4. D 8. D

Part 2.

a)



$$E = jX_s I + V$$

$$V = 1 \mu$$

$$S = \frac{P}{0.9} e^{j \arccos(0.9)}$$

$$P = 80 \text{ MW} \rightarrow 0.8 \mu$$

$$S = V I^* = I^* \rightarrow I = \frac{0.8}{0.9} e^{-j \arccos(0.9)} \rightarrow 5.132 \text{ K A}$$

$$|E| = |j \cdot 0.9 \cdot \frac{0.8}{0.9} e^{-j \arccos(0.9)} + 1| = 1.5289 \mu \rightarrow 15.289 \text{ KV}$$

$$\cos(\phi) = \frac{P}{S} \quad S_b = 100 \text{ MVA}$$

$$V_b = 10 \text{ KV}$$

$$I_b = \frac{S_b}{\sqrt{3} V_b}$$

b)

CC: $V_{cc} = 5\% \rightarrow Z_t = 0.05$

$P_{cc} = 500 \text{ KV} \rightarrow R_t = 0.005$

$X_t = \sqrt{Z_t^2 - R_t^2} = 0.04975$

$Z_t = 0.005 + j 0.04975$

OC: $I_0 = 115 \text{ A} \rightarrow Y_m = 0.0199$

$P_{oc} = 150 \text{ KV} \rightarrow G_m = 0.0015$

$B_m = -\sqrt{Y_m^2 - G_m^2} = 0.0198$

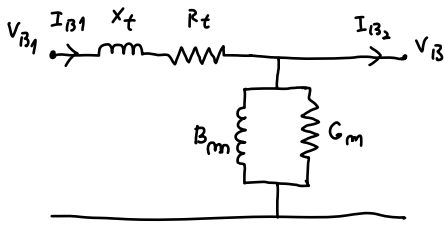
$Y_m = 0.0015 - j 0.0198$

$V_m = Z_t \cdot I_{B1}$

$V_{B2} = V_{B1} - V_m = 215.04 \text{ KV}$

$I_m = V_{B2} \cdot Y_m$

$I_{B2} = I_{B1} - I_m = 230.9 \text{ A}$



c)

$P = \operatorname{Re}\{3 \cdot V_{B2} \cdot I_{B2}^*\} = 79.46 \text{ MW}$

$P_{Cu} = I_1^2 \cdot R_t = 395.062 \text{ kW}$

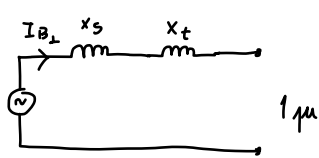
$P_{Fe} = V_2^2 \cdot G_m = 143.315 \text{ kW}$

d)

$P = \operatorname{Re}\{V_{B2} \cdot I_{B2}^*\} = \operatorname{Re}\{I_{B2}^*\} = 0.7446$

$V_{B2} = 1$

$I_{B2} = 0.7446$



$\operatorname{Im}(s) = X I \cos(\phi)$

$E = \frac{XP}{\operatorname{Im}(s)} = 1.603 \rightarrow \Delta I = 4.8\%$

E) $V_2 = 1 \mu$
 $S_2 = 79,5 + j32,9 \text{ [MW, MVar]}$

$$Z = R + j\omega L$$

$$A = 1 + \frac{ZY}{2} d^2$$

$$Y = j\omega C$$

$$B = Zd$$

$$C = Yd \left(1 + \frac{ZY}{4} d^2\right)$$

$$Z_d = 12 + j88$$

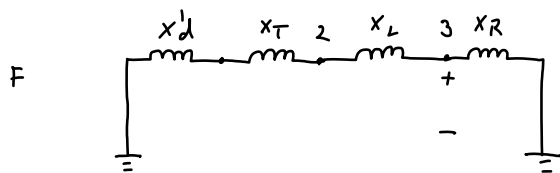
$$Y_d = j0,5 \times 10^{-3}$$

$$\begin{bmatrix} V_E \\ I_E \end{bmatrix} = \begin{bmatrix} A & B \\ C & A \end{bmatrix} \begin{bmatrix} V_R \\ I_R \end{bmatrix}$$

$$\begin{bmatrix} A & B \\ C & A \end{bmatrix}^{-1} \cdot \begin{bmatrix} \frac{220}{\sqrt{3}} \times 10^3 \\ (79,5 - j32,9) \times 10^6 \\ \frac{3 \cdot 220 \cdot 10^3}{\sqrt{3}} \end{bmatrix} = \begin{bmatrix} 115,331 \\ 251,982 \end{bmatrix}$$

$$I_R = 251,5 \text{ A}$$

$$V_R = 199,8 \text{ kV}$$



$$X'_d = 0,2$$

$$X_T = 0,05$$

$$X_L = 2 \cdot \pi \cdot 50 \cdot 1,4 \times 10^{-3} \cdot 200 / \frac{220^2}{100} = 0,1817$$

$$X_R = \frac{1}{\frac{1000}{100}} = \frac{1}{10} = 0,1$$

$$Z_{th} = X_{th} = (X'_d + X_T + X_L) // X_R =$$

$$= 0,0811 =$$

$$= 39,29 \Omega$$

6) $I_{cc} = \frac{1}{X_{th}} \rightarrow V_2 = \frac{X_R}{X'_d + X_T + X_L + X_R} \cdot I_{cc} \cdot X_L \cdot V_b = 92,9 \text{ V}$

↓

$$I_s = 13,97 \text{ A}$$